Single Ge Quantum Well via a Hybrid Combination of MBE/CVD Growth

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SiGe/Ge/SiGe heterostructures system with Germanium (Ge) as its quantum well (QW) is becoming attractive and a strong candidate for semiconductor spin-qubits applications. This is mainly due to its net-zero nuclear spin for isotopically purified Ge [1]. Furthermore, due to its higher mobility compared to silicon and higher splitting between the *heavy-hole* (*hh*) and *light-hole* (*lh*) states in the valence band, *heavy-hole* spins can be manipulated relatively better compared to Si [2]. In this work, we report the fabrication of $Si_{1-x}Ge_x$ /Ge/ $Si_{1-x}Ge_x$ heterostructures for qubits via a hybrid molecular beam epitaxy (MBE)/chemical vapour deposition (CVD) growth. A thick relaxed $Si_{0.2}Ge_{0.8}$ directly grown or a thick Ge virtual substrate (VS) on Si (100)-oriented substrate are realised by CVD. The $Si_{1-x}Ge_x$ /Ge/ $Si_{1-x}Ge_x$ heterostructures are grown by MBE. The samples are characterized via atomic force microscopy (AFM), selective high-angle backscattered electrons (HA-BSE) scanning electron microscopy (SEM) and Raman spectroscopy.

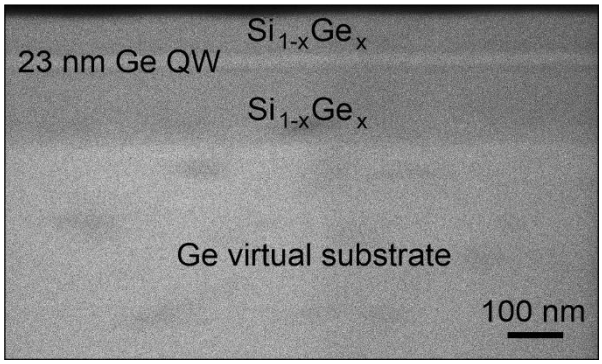

Fig.1 Cross-section $Si_{1-x}Ge_x$/Ge/$Si_{1-x}Ge_x$ heterostructure grown via MBE using CVD grown Ge VS/Si (100) substrate. Using HA-BSE SEM mode white contrast corresponds Ge QW and Ge VS while darker contrast corresponds $Si_{1-x}Ge_x$ barrier.

References

1. K. Itoh, et al., J. Mater. Res. **8**, 1341 (1993).
2. N. W. Hendrickx, et al., Nat. Comm. **9**, 2835 (2018).